SECTION 109
RIPRAP STONE

109.1 GENERAL

The riprap stone provided and installed under this specification shall be angular rock, stone or recycled Portland cement concrete complying with the requirements of this specification. The material shall be certified to comply with the specification in accordance with the requirements of Section 13. If a change in material and/or source from that authorized occurs during a project, the CONTRACTOR shall resubmit to include the changed material/and or source for authorization by the ENGINEER. A riprap material shall not be used on a project without written authorization of the ENGINEER.

109.2 REFERENCES

109.2.1 American Society of Testing and Materials (Latest Edition)(ASTM)
- C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate Solution
- C127 Specific Gravity and Absorption of Coarse Aggregate
- C535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

109.2.2 American Association of State Highway and Transportation Officials (Latest Edition)(AASHTO)
- T103 Soundness of Aggregates by Freezing and Thawing

109.2.3 This Publication
- 603 Rip Rap Surface Treatment
- 610 Gabions

109.3 MATERIAL

109.3.1 Riprap stone shall be stone, rock or recycled Portland cement concrete complying with this specification. The material shall be free of seams, fractures and coatings and of such characteristics that it will not disintegrate when subject to the action of flowing water.

109.3.2 The minimum specific gravity of the stone shall be 2.65 for sizes and gradation specified in TABLE 209.A, as determined in accordance with ASTM C127, latest edition. If the specific gravity of a stone is less than 2.65, the minimum size of the stone and the depth of the riprap shall be increased in accordance with TABLE 109.B.

109.3.3 The maximum resistance to abrasion shall be fifty (50) percent determined in accordance with the requirements of ASTM C535.

109.3.4 The maximum soundness loss shall be twenty (20) percent determine in accordance with ASTM C88.

109.3.5 The maximum loss to freeze thaw shall be ten (10) percent for 12 cycles determined in accordance with the AASHTO T103, Ledge R, Procedure A.

109.4 SHAPE AND GRADATION

109.4.1 Riprap material shall be rectangular in shape having maximum to minimum dimension ratio not more than 3:1.

109.4.2 Riprap stone shall comply with the gradation requirements of TABLES 109.A and 109.B.

109.4.3 Waste Portland cement concrete complying with the requirements of this specification may be used as riprap as specified in the plans and specification, as directed by the ENGINEER.

109.5 PLACEMENT

109.5.1 The placement of riprap stone shall be to the line and grade shown on the plans or as authorized by the ENGINEER. The depth of the riprap shown on the plans shall be adjusted based on Table 109.B for the specific gravity of the material provided. The surface tolerances shall be within the maximum variations shown in Table 109.C.

109.6 MEASUREMENT AND PAYMENT

109.6.1 Riprap shall be measured by the cubic yard (cy) placed to the lines and grades in the plans and specifications complete in place.

109.6.2 Payment for riprap will be made at the contract unit price per cubic yard for the type of riprap required, which payment shall include all material, labor and equipment required in placing riprap stone as specified in Section 603 and/or 610.

TABLE 109.A
CLASSIFICATION GRADATION

DESIGNATION	MAXIMUM DIMENSIONS inches (m)	% SMALLER	Km [1]
A. GABIONS			
TYPE VL	12 (0.30)	100	
	9 (0.25)	50-70	
	6 (0.15)	35-55	6
	3 (0.08)	10	
TYPE L	18 (0.45)	100	
	12 (0.30)	50-70	
	6 (0.15)	30-55	9
	3 (0.08)	10	
B. RIPRAP			
TYPE M	24 (0.60)	100	
	18 (0.45)	50-70	
	12 (0.30)	30-55	12
	6 (0.15)	10	
TYPE H	36 (0.90)	100	
	24 (0.60)	50-70	
	12 (0.30)	30-55	18
TYPE VH	48 (1.20)	100	
	36 (0.90)	50-70	
	18 (0.45)	30-55	24
	9 (0.23)	10	

[1] Km = mean particle size

TABLE 109.B
SPECIFIC GRAVITY MULTIPLIER

SPECIFIC GRAVITY	MULTIPLIER
2.65	1.00
2.60	1.05
2.50	1.15
2.40	1.25
2.30	1.35
< 2.30	REJECT

TABLE 109.C
CONSTRUCTION TOLERANCES

RIPRAP DESIGNATION	MAXIMUM VARIATION FROM SPECIFIED FINISH GRADE inches (meters)
TYPE VL	+/- 3 (0.08)
TYPE L	6 (0.15)
TYPE M	9 (0.25)
TYPE H	12 (0.30)
TYPE VH	+/- 12 (0.30)